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Study on Fall Protection from Scaffolds by Scaffold Sheeting During Construction

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Abstract

The frequency of fall accidents is one of the most serious problems in construction industries, and the countermeasures, such as guidelines, etc., for falls from scaffolds have been tightened in Japan. These countermeasures particularly affect the decrease in the number of the fatal accidents by falls from scaffolds. However, the rate of such accidents from falls is still high in the construction industries. In order to examine further countermeasures to reduce falls, the Japanese Ministry of Health, Labor, and Welfare has established a committee at the authors' institute.

That committee's work experimentally confirmed the effectiveness of using scaffold sheeting as a covering around scaffolds to protect against falling construction materials (a method widely used in Japan). Based on those results, the scaffold sheeting was improved for fall protection, and the effect of the improved sheeting could be confirmed experimentally.

Keywords: Fall accident; Scaffold; Scaffold sheeting; Construction safety.

1. INTRODUCTION

Falling accidents are a serious problem in the construction industry in Japan, as approximately 40% of fatal accidents during construction are caused by workers' falls. Therefore, Japan has introduced countermeasures to reduce falls from scaffolds and strictly enforces these measures with various safety

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guidelines. These countermeasures have led to a reduction in the rate of fatal accidents caused by falling from scaffolds.

Because the rate of fatal accidents from falls is still high, however, in the construction industry, possible countermeasures became the main issue of the 11th Labor Accidents Prevention Plan in Japan. In order to examine further countermeasures to reduce such falls, the Japanese Ministry of Health, Labor, and Welfare (MHLW) established a committee at the authors' institute to conduct an investigation of the regulations that exist in overseas countries and to evaluate various construction methods according to present safety guidelines.

From the results and the discussion, it was found that workers sometimes fell from the space between the hand rail and the work platform. To prevent the fall of the workers from this space, the space has to be narrowed. The scaffold sheeting, which covers around the scaffolds and is widely used in Japan, as shown in Photo 1, had some effect for this purpose according to the experiment by the committee. However, the workers still occasionally fell from the space between the work platform and the scaffold sheeting. One reason for this is because the space was spread by the workers weight, as shown in Photo 2, and the workers fell from the spread space (Ohdo et al. 2009). Therefore, in this study, the scaffold sheeting, which was plastic, was improved for fall protection from the spread space, and the effect of the improved plastic sheeting was examined experimentally.

Photo 1: Scaffolds covered with sheeting.

Photo 2: The spread space by the workers weight.

2. WORK EFFICIENCY BY GUARDRAIL-FIRST ERECTION METHOD

In Japan, the guardrail-first erection method is occasionally used for fall protection of the scaffolds as shown in Photo 3, and MHLW is aiming to spread the method by their safety guidelines. However, the method is not wide spread because of poor work efficiency.

Photo 3: Prefabricated scaffolds constructed by guardrail-first erection method.

Figure 1 shows the results of a questionnaire survey on the work efficiency of the method shown in Photo 3. 18 workers answered the questionnaires. More than 80% of the workers felt that the method took more time, was complex, and had heavy pieces for the erection of the scaffolds.
Figure 2 and Figure 3 show the results of the survey on the safety and use of the method, respectively. Approximately 90% of the workers felt that the scaffolding work improved safety, but more than 60% of the workers answered that they did not want to use the method because of its poor work efficiency.
Therefore, in this study, the safe and easy installation method for fall protection for the scaffolds was developed by improving the scaffold sheeting.

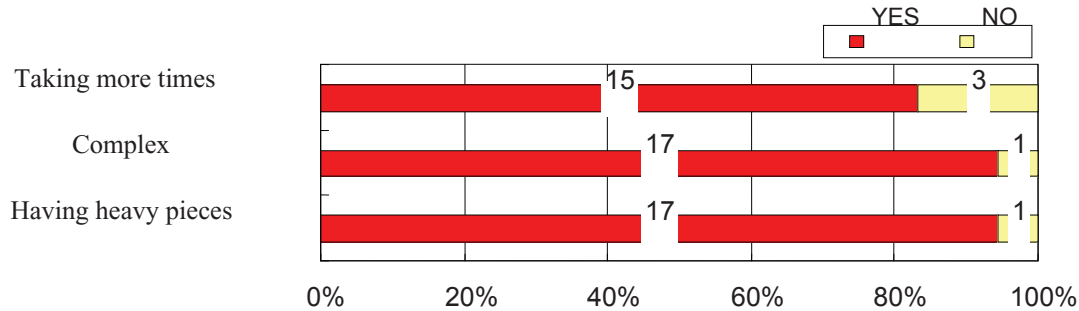

Figure 1: Results of a questionnaire survey on the work efficiency of the guardrail-first erection method.

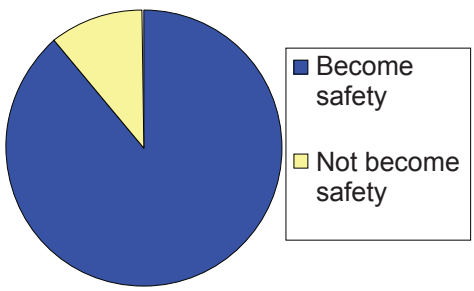

Figure 2: Results of the survey on the Safety of the guardrail-first erection method.

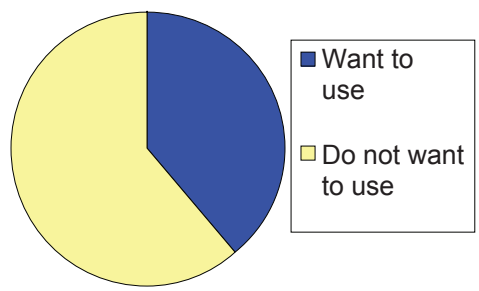

Figure 3: Results of the survey on the use of the guardrail-first erection method.

3. IMPROVEMENT OF PLASTIC SHEETING

In this study, the plastic sheeting was improved for fall protection from the spread space, as shown in Figure 4. The improved sheeting has additional attached sheets, as shown in Photo 4, and the attached sheets were sewn with the plastic sheeting near the work platform.
The effect of the improved plastic sheeting was examined experimentally by using a sand bag or human dummy.

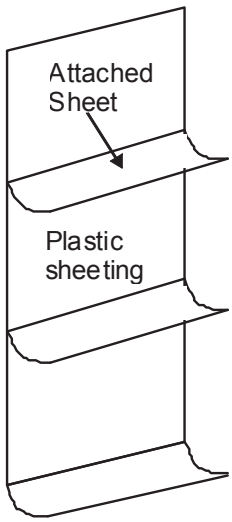

Figure 4: Improved sheeting.

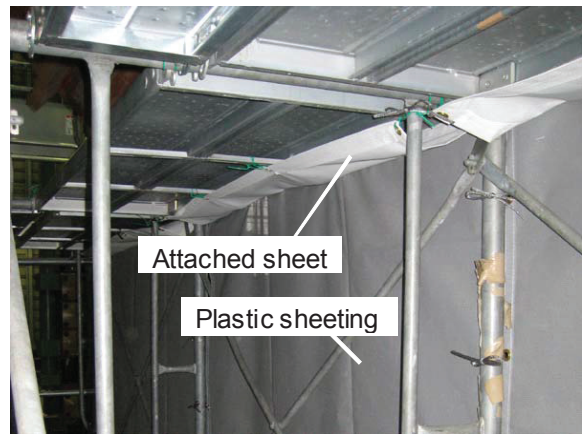

Photo 4: Attached sheet sewn with plastic sheeting.

3.1. Experimental method

Table 1 shows experimental conditions for examining the effect of fall protection provided by the improved sheeting. The attached sheets were fixed to the work platform by three kinds of materials.

a: Fiber rope
b: Steel wire with a diameter of 1.0 mm
c: Steel wire with a diameter of 2.3 mm

Table 1: Experimental conditions

Case	Fixed by	Fall Height	Fallen object
1	Fiber rope	640 mm	Sand bag
2	Wire(1.0mm)	640 mm	Sand bag
3	Wire(2.3mm)	640 mm	Sand bag
4	Wire(2.3mm)	640 mm	Human dummy
5	Wire(2.3mm)	1000 mm	Human dummy
6	Non	640 mm	Human dummy

The experiments were performed by using a sand bag and a human dummy. The sand bag or human dummy were dropped from the height of 640 mm above the work platform into the spread space by using a slide. Only in case 5, the human dummy was dropped from the height of 1000 mm in order to confirm the further safety, as shown in Photo 5.

The weight of the sand bag and human dummy was 735 N for each. The space between the plastic sheeting and the work platform was set to be 160 mm, which was the maximum space of the prefabricated scaffolds, as shown in Figure 5.

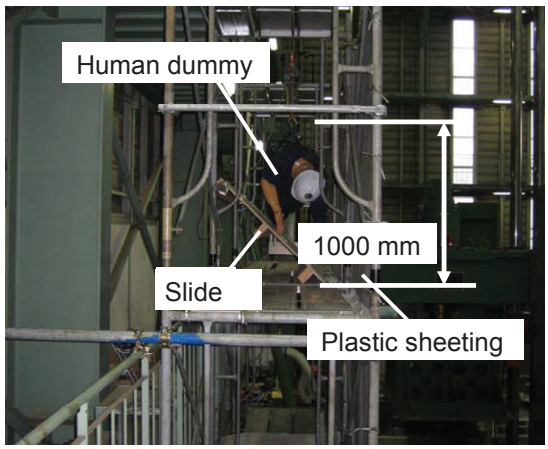

Photo 5: Fall from height of 1000 mm.

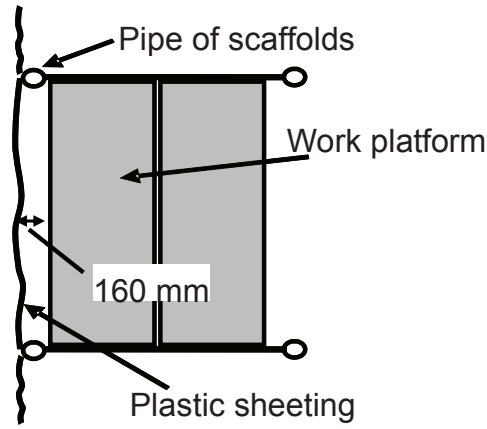

Figure 5: The space of 160 mm.

3.2. Results of experiment

Table 2 shows the results of the experiment. For cases 1-2, the sand bag fell below the work platform. Therefore, the fiber ropes and the steel wire with 1.0 mm diameter were severed by the mass of the sand bag. However, the sand bag did not fall below the work platform for case 3, as shown in Photo 6.
From the results of cases 1 and 2, the fiber ropes and the steel wire with 1.0 mm diameter would not be used as the materials for fixing the attached sheets to the work platform. Therefore, a steel wire with 2.3 mm diameter was used as the material for fixing the attached sheets, in cases 4 and 5. Additionally, the human dummy was used for the fallen object in those tests.

Table 2: Results of experiment

Case	Fixed by	Fall Height	Results(Fell / Not fall)
1	Fiber rope	640 mm	Fell, sand bag
2	Wire(1.0mm)	640 mm	Fell, sand bag
3	Wire(2.3mm)	640 mm	Not fall, sand bag
4	Wire(2.3mm)	640 mm	Not fall, human dummy
5	Wire(2.3mm)	1000 mm	Not fall, human dummy
6	Non	640 mm	Fell, human dummy

For case 5, the human dummy did not fall below the work platform, even though the fall height was 1000 mm, as shown in Photo 7. However, for case 6, in which the attached sheets were not fixed to the plastic sheeting to mimic the normal construction condition, the human dummy fell below the work platform, as shown in Photo 8. Therefore, it can be concluded that the improved sheeting was effective for fall protection from the scaffolds when the attached sheets were fixed by steel wire with at least a 2.3 mm diameter.

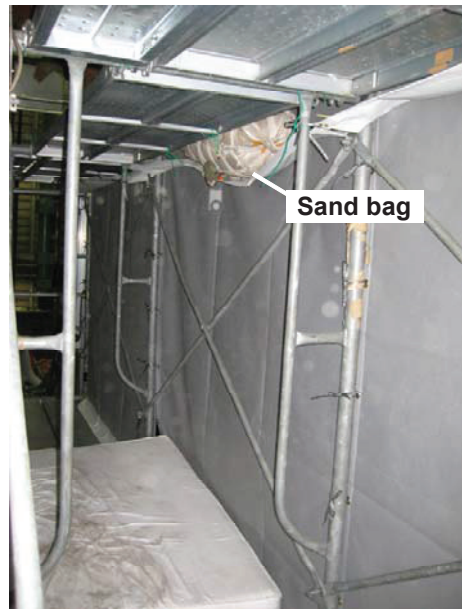

Photo 6: Result of case 3.

Photo 7: Result of case 5.

Photo 8: Result of case 6.

3.3 Improvement of work efficiency of the improved sheeting

Case 7 in Table 3 was performed to improve the work efficiency, and the fixing material was changed from steel wires to twisted pair fiber ropes. Then, the weight of the human dummy was increased from 735 N to 833 N for confirming further safety. In this case, the human dummy also did not fall below the work platform, and the work efficiency could be slightly improved. Consequently, the sheeting has been designed to be improved continuously.

Table 3: Results of experiment for improvement of work efficiency

Case	Fixed by	Fall Height	Results(Fell / Not fall)
7	Twisted pair fiber rope	1000 mm	Not fall, human dummy

4. CONCLUDING REMARKS

In this study, the scaffold sheeting was improved for fall protection from scaffolds, and the effect of the improved sheeting was examined experimentally. The results are summarized as follows.

(1) The plastic sheeting was improved for fall protection from the spread space by sewing additional attached sheets.

(2) From the results of the experiments, it was found that the improved sheeting was effective for fall protection from the scaffolds when the attached sheets were fixed by steel wires with a diameter of 2.3 mm.

(3) The work efficiency could be slightly improved when the fixing material was changed from steel wires to twisted pair fiber ropes. Consequently, the sheeting has been designed to be improved continuously.

5. ACKNOWLEDGMENTS

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